# Space Weather Technical Forecast

Issued on Wednesday, 11 October 2023 at 13:06 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: M-class flares likely days 1 & 2 (11-12 Oct), a chance of M-class flares days 3 & 4 (13-14 Oct). Chance G1/Minor G2/Moderate Geomagnetic Storm intervals days 1 & 2. Slight chance of R1/Minor Solar Radiation Storm throughout.**

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Moderate with an M2.3 flare, peaking at 10/1217UTC, originating from AR3451 in the northwest. There are currently nine sunspot regions on the visible disc. AR3451(Eai/Beta-Delta) remains the largest region on the disc with the delta spot on its main trailer region. AR3460, near south-centre disc, maintains a relatively complex structure with a delta spot on its main trailing portion, though showing slight signs of recent decay. The final notable spot is the newly numbered region AR3465 rotating around the northeast limb. This appears to be a large spot, perhaps with some magnetic complexity, though is difficult to analyse due to foreshortening effect. All other regions appear to be small and relatively simple at present. No Earth-directed CMEs have been detected in coronagraph imagery in the past 24 hours.

**Solar Wind / Geomagnetic Activity:** Solar winds as observed at L1 by ACE/DSCOVR have persisted at generally slow-ambient conditions, with no indication of CH57/- fast winds. The solar wind speed has shown a slight downwards trend from 360kms to around 280km/s. Density was well below average. Total interplanetary magnetic field (IMF) strength, Bt, was weak throughout. The north-south component, Bz, was weak and variable, ranging from -4/+4 nT. Phi angle was predominately positive (away from the Sun). Geomagnetic activity has been Quiet (Kp 0-1).

**Energetic Particles / Solar Radiation:** GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was Background to Moderate. Associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold. The observation at 11/0000 UTC was 1.44e6 integrated pfu.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Moderate activity is likely to continue initially with isolated M-flares. The risk may then reduce from 13 Oct as AR3451 departs the disc, although, returning regions during the period bring a potential further increase risk of M-flares. There is a very slight chance of an isolated X-flare throughout.

**Solar Wind / Geomagnetic Activity:** A CME associated with the C6.6 flare originating from AR3460 that left the Sun on 08/0339 UTC, is forecast to arrive at Earth late day 1 (11 Oct), or more likely early day 2 (12 Oct). No further Earth-directed CMEs have been observed. Slow wind conditions initially. Earth is likely to move into the fast wind from CH58/- during day 1 (11 Oct), peaking at slightly elevated or elevated levels of 450-550 km/s and lasting until early on day 3 (13 Oct). Through day 3 and into day 4 (13-14 Oct) winds are anticipated to gradually ease towards background. Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected initially, this increasing to largely Unsettled to Active (Kp 3-4) later on day 1 and into day 2 (11/12 Oct) with a chance of G1/Minor or G2/Moderate storm periods due to a coronal hole high speed

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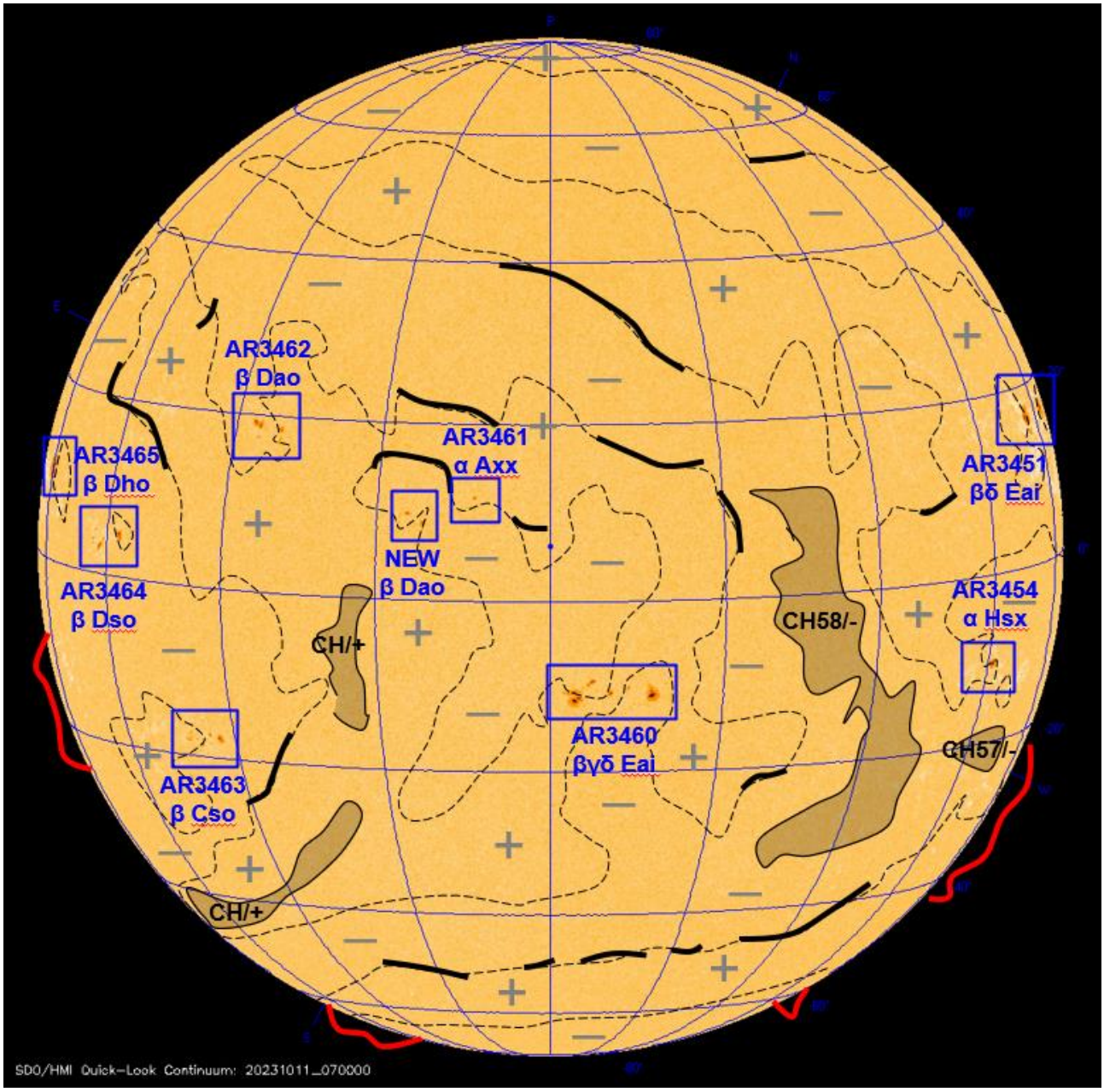
stream and/or a combined CME impact. Activity easing to mainly Quiet (Kp 0-2) from Day 3 (13 Oct).

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, with a slight chance of enhancements to R1/Minor Solar Radiation Storm levels if any notable flares occur. High energy electron flux (greater than 2MeV) is forecast to remain largely at background to moderate levels, dropping out with any fast wind or CME arrivals before potentially increasing from Day 3 (13 Oct). Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

**Figure 1. Solar Analysis Valid 11/0700 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

A CME associated with the C6.6 flare of AR3460 that left the Sun on 08/0339 UTC, is forecast to arrive at Earth late day 1 (11 Oct), or more likely early day 2 (12 Oct). No further Earth-directed CMEs have been observed.

Slow wind conditions initially, the fast wind of CH57/- is likely to have passed below Earth. Earth is still likely to move into the fast wind from CH58/- anytime from early on day 1 (11 Oct), peaking at slightly elevated or elevated levels of 450-550 km/s and lasting until early on day 3 (13 Oct). ENLIL is now thought to be overdone with timings and speeds of high speed streams, though SWPM is perhaps closer to the expected speeds of CH58/-. Through day 3 and into day 4 (13-14 Oct) winds are anticipated to gradually ease towards background.

Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected initially, this increasing to largely Unsettled to Active (Kp 3-4) through day 1 and into day 2 (11/12 Oct) with a chance of G1/Minor or G2/Moderate storm periods due to a coronal hole high speed stream and/or a combined CME impact. Activity easing to mainly Quiet (Kp 0-2) from Day 3 (13 Oct).

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 30 | 30 | 5 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 08/1435 | Partial | AR3460 | SE | 460km/s | Late 11/Early 12 | Dependent of CH fast wind preceding |

**Figure 2: MOSWOC Enlil (top) and Ensemble (bottom) – shows likely arrival of a CME either late on 11 Oct or early 12 Oct.**

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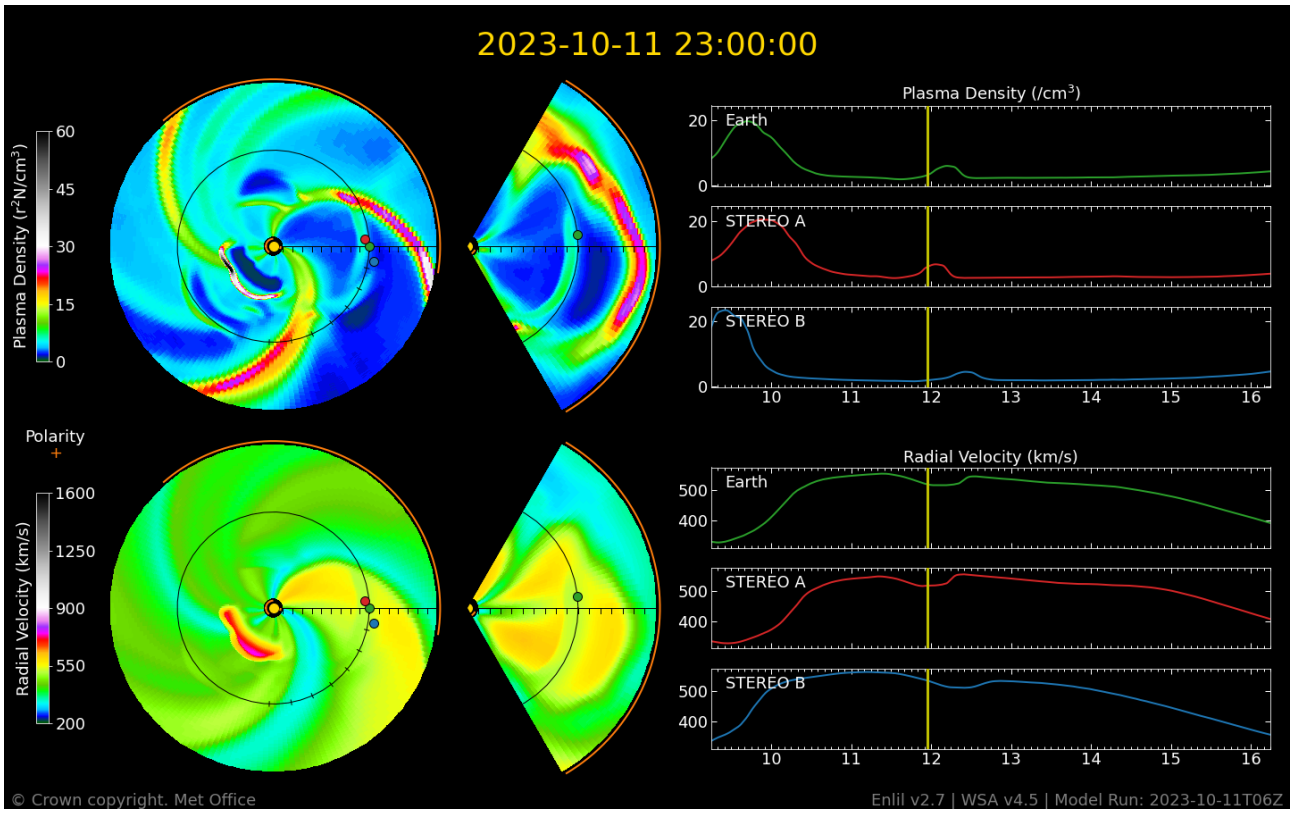


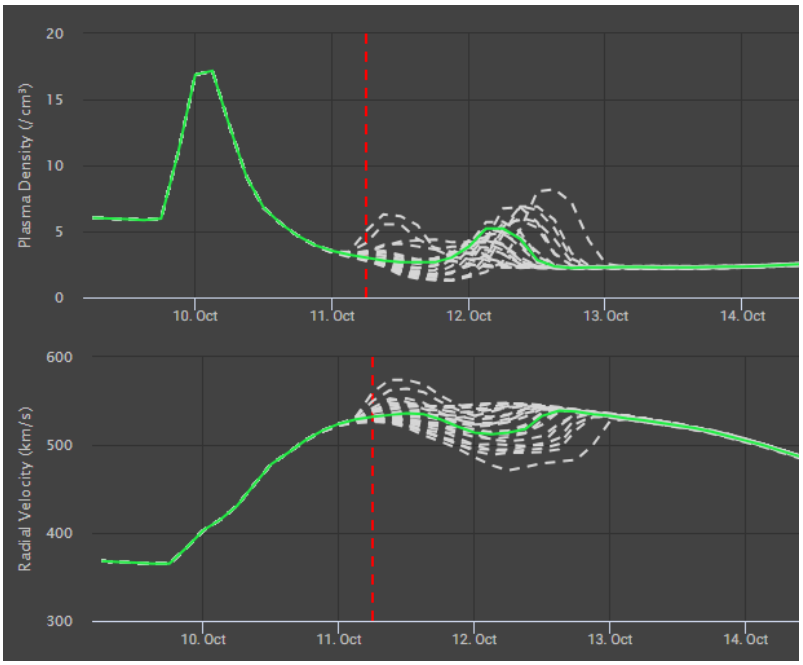


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**Radio Blackouts - X-Ray Flares:**

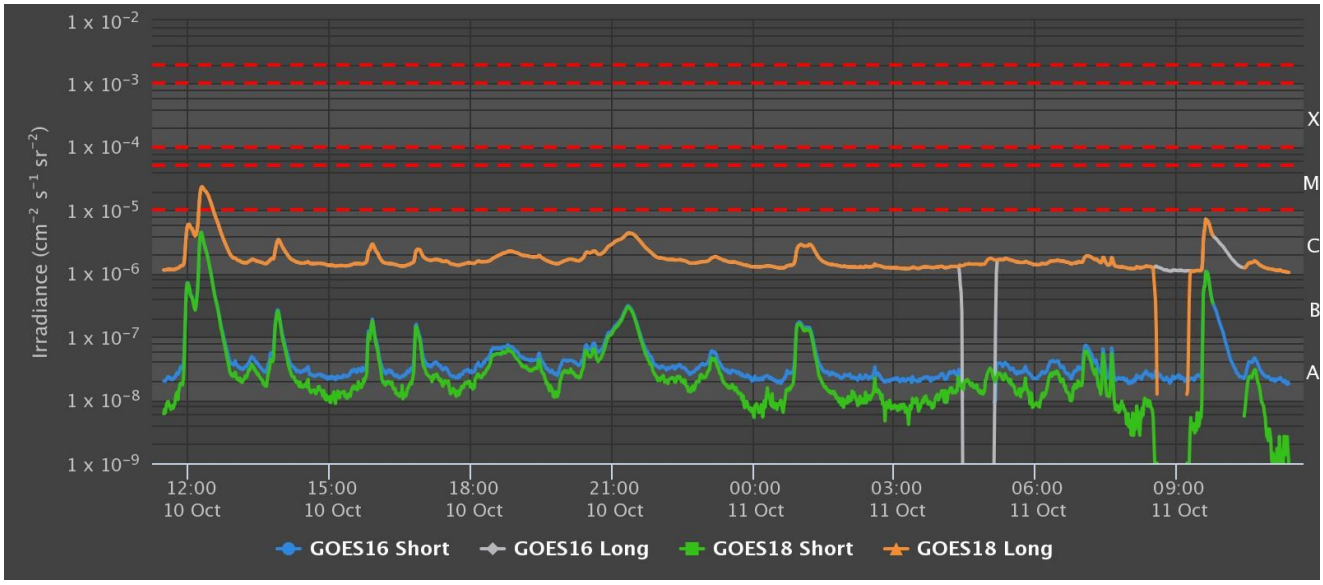
There are currently nine sunspots on the visible disc. AR3451 remains the largest region on the disc with the delta spot on its main trailer region maintained. AR3460, near centre disc, maintains a relatively complex structure with a shrinking delta spot on its main trailing portion, though showing continued signs of decay. The final notable spot is the new currently unnumbered region on the northeast limb. This appears to be a large spot, perhaps with some magnetic complexity, though is remains difficult to analyse due to foreshortening. Another new and unnumbered spot has recently emerged northeast centre disc, which will need to be monitored for any further development. All other regions appear small and relatively simple at present.

Moderate activity during the last 24 hours, with one M-class flare. Peak flare M2.3 at 10/1217 UTC from AR3451. Moderate activity is expected to continue, with further isolated M-flares considered likely. There is a slight chance of an isolated X-flare emanating from either AR3451, AR3460 or perhaps the newly numbered AR3465 on the northeast limb.

Solar Activity is forecast to be Moderate with an ongoing risk of isolated M-class flares. M-flares are considered likely Days 1 & 2 (11/12 Oct) until AR3451 rotates around the northwest limb. The risk is expected to reduce slightly Day 3 Day 4 (13/14 Oct) though the returning regions (AR3465) in the northeast may maintain this risk throughout.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 60 | 60 | 50 | 50 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

**Figure 3: GOES-Xray flares**

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## Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at background levels. There are two spots currently with small delta spots, and given their locations, there is an increased potential for proton flux to rise should any notable flares occur. This risk decreases from day 3 (13 Oct) as AR3451 rotates around the northwest limb. A slight chance of S1/Minor Solar Radiation Storms is maintained throughout the period.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ S1 | No | 10 | 10 | 5 | 5 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 has peaked at moderate levels at the diurnal maximum in recent days, but is expected to continue at mainly background levels. Any fast wind arrival from CH58/- may act to initially supress observed values, alongside the potential CME arrival late Day 1 or Day 2 (11-12 Oct) but will see an increase in electron flux through the Van Allen Belts at lower orbits. This may lead to the observed flux at GEO increasing as solar wind pressure eases, bringing a chance of Moderate levels, perhaps peaking at High Day 3 onward (13-14 Oct).

Electron fluence is forecast to be well below the Active (1e8 integrated pfu) level throughout, however, albeit with an increasing trend from late Day 3 or Day 4 (13-14 Oct). MOSWOC REFM output is currently considered to be giving good guidance.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 5 | 20 | 20 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

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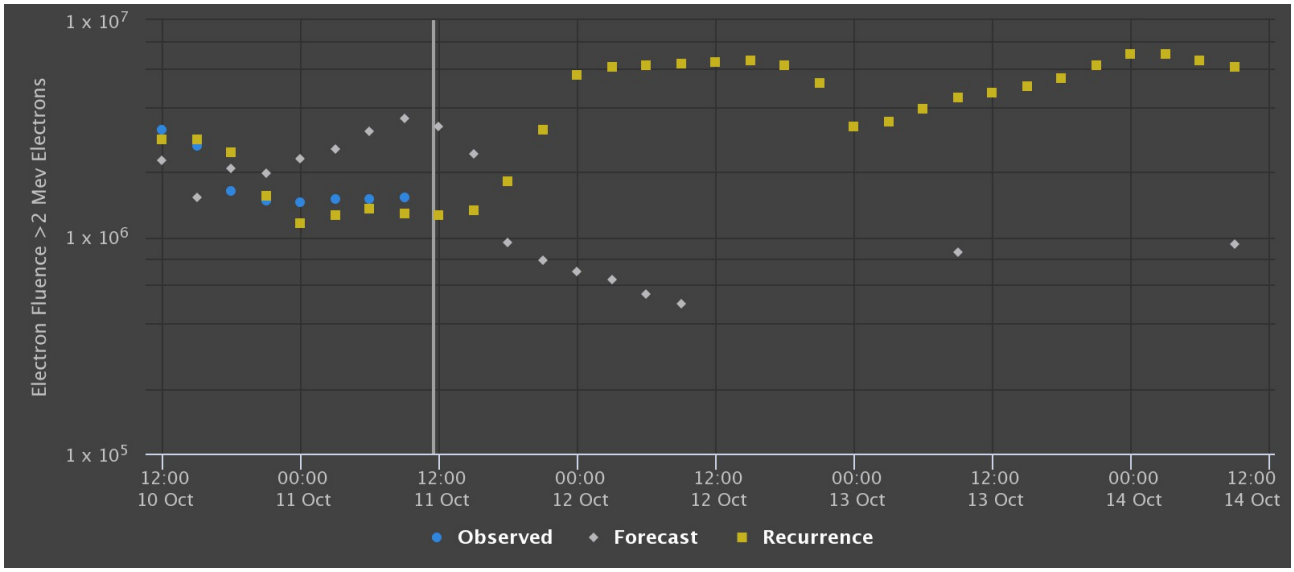
**Figure 4: MOSWOC REFM – electron fluence, observed, forecast and recurrence.**

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